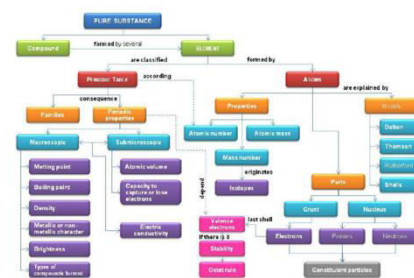




LANGUAGE STRUCTURE: COMPARATIVES AND SUPERLATIVES





Glossary:

amphoteric - able to behave as both an acid and a base.

electronegativity - the ability of an atom to attract the bonding electrons in a covalent bond.

ionization energy - the energy needed to remove 1 mole of electrons from 1 mole of atoms of an element in the gaseous state to form 1 mole of gaseous ions.

Periodic Table - the repeating patterns in the physical and chemical properties of the elements across the periods of the Periodic Table.

electron arrangement - a shorthand way of writing the number of electrons in an atom's electron shells.

group - a column in the periodic table containing elements with the same number of outer shell electrons and similar chemical



Reading: Periodicity



Listen to the recording and mind pronunciation of words.

Periods in the Periodic Table are rows of elements whose outermost electrons are in the same principal quantum shell. The atoms of neighboring members differ by one proton and one electron. As atomic number increases, the properties of the elements show trends which repeat themselves in each Period of the Periodic Table. These trends are known as Periodic Trends. A column of elements thus arranged is called a group.

Atomic radii decrease across a period due to increasing nuclear charge. This means electrons are pulled closer to the nucleus, making the atomic radius smaller. Positive ions are much smaller than their atoms. Negative ions are slightly larger than their atoms.

The first ionization energy of an element is the energy required to remove one electron from each of a mole of free gaseous atoms of that element. A high ionization energy means there is a high attraction between the electron and the nucleus and so more energy is needed to remove the electron. The greater the number of protons, the greater the attraction of the electrons to the nucleus and the harder it is to remove the electrons. Attraction falls off very rapidly with distance. An electron close to the nucleus will be much more strongly attracted than one further away. As the number of electrons between the outer electrons and the nucleus increases, the outer electrons feel less attraction towards the nuclear charge. This lessening of the pull of the nucleus by inner shells of electrons is called shielding. The first ionisation energy increases across a period because the nuclear charge increases but the shielding remains the same. Electronegativity increases across period due to increasing number of outer electrons.

Across a period, the structures of the elements change from giant metallic, through giant molecular to simple molecular. Group 18 elements consist of individual atoms. There is a gradual decrease in metallic character in crossing a period. Electrical conductivity increases from sodium to aluminium as the number of delocalized electrons per atom increases. Across a period, the oxides of Period 3 elements change from basic compounds with ionic bonding through to giant molecular in the centre of the period (Group 14) with silicon, going on to acidic covalently bonded simple molecules of the non-metal oxides. Aluminium oxide (in Group 13) is amphoteric, exhibiting both basic and acidic behavior. Across a period, the chlorides of Period 3 elements change from ionic compounds that dissolve in water to covalent compounds that are hydrolyzed by water, releasing fumes of hydrogen chloride and leaving an acidic solution.



Practice exercises: Periodicity

properties.

period – a row in the periodic table containing elements with the same number of full electron shells.

Property – Any characteristic of an element.

Trends down a group:
the number of outer shell electrons is the same;
the number of complete electron shells increases by one.

Trends across a period:
the number of outer shell electrons increases by one;
the number of complete electron shells stays the same.

acid – a substance that dissociates in water to produce hydrogen ions, or which donates protons and/or accepts electrons. Acids produce aqueous solutions with a pH less than 7.

alkali – a substance that dissociates in water to produce hydroxide ions, or which accepts protons and/or donates electrons. Alkalis form aqueous solutions

having a pH greater than 7.

amphoteric – a substance that has the characteristics of an acid and an alkali and is capable of reacting chemically either as an acid or an alkali. For example, aluminium oxide (Al_2O_3) is amphoteric: it reacts with acids to produce salts, and with alkalis to produce aluminates (substances containing the ion $[\text{Al}(\text{OH})_4]^-$).

base – a compound that dissolves in water to produce an alkaline solution.

metal – an element, such as sodium and aluminium, formed from a regular lattice consisting of positively-charged metal ions surrounded by a sea of delocalized electrons and held together by the attraction between them (metallic bonds). Metals are found on the left and middle of the periodic table.

metalloid – an element, such as silicon, that has

properties (such as electrical conductivity) intermediate between metals and non-metals.

non-metal – an element, such as sulfur and chlorine, that typically has physical properties that are opposite to that of metals. For example, they typically have low melting and boiling points, solid non-metals are usually brittle, dull and act as electrical insulators. Chemically, non-metal oxides tend to be acidic. Non-metals are found on the right of the periodic table.

oxidation state – the charge a particular atom in a compound would have if the compound consisted entirely of separate ions. Also called the oxidation number. In ions, the oxidation state is the ionic charge. Elements are assumed to exist in the zero-oxidation state.

Simple FORMULA of asking questions in English: **there is / there are**

There is – for singular

There are – for plural

Question word + <u>what</u>	are there is there	Where
How many <u>groups</u>	are there	in Periodic table?

create

- **There are** trends in ionization energy described for the 2nd group and 3rd period. Refer back to Unit 1. Electron Shell, Ex. 5 and Ex.6. Create similar trend for elements of 3rd group and 2nd period.

evaluate

- **There is** an element which has more rapid reaction with water. Using the number of atomic radius (nm) X – 0.112, Y – 0.219 or Z – 0.194, predict this element.

analyse

- What is the order of decreasing radii **is there** in these species Cl, Cl⁺, Cl⁻?

apply

- How many valence (outer shell) electrons **are there** in the element with atomic number 51?
- Where is an element in with electronic configuration [Arg] 4s¹ 3d¹⁰ **are there** in Periodic Table?

understand

- **Is there** a difference between melting points of MgO, SiO₂ (quartz), P₄O₁₀, SO₂? Explain the reason of their difference.

remember

- How many groups and periods **are there** in Periodic Table?



Video worksheet

“How does Periodic Table Work”



! This is an authentic video. Do not try to understand every word you hear. Watch and listen for general and specific information by completing the following tasks.

Before you watch:

Exercise 1. Explain the meaning of the following numbers in Periodic Table.

7 called

18 called

While you watch:

Exercise 2. Watch the first part of the video (till 00:21) and check your answers to Exercise 1.

Exercise 3. Watch the next part of the video (00:22-1:56) and answer questions.

Question 1. How are the elements in periodic table arranged?

Question 2. What does the period show?

Question 3. What does the group show?

Question 4: Watch an example of Cl and write electronic configuration for carbon atomic number 6 period 2 and group 14 (PAUSE the video)

Exercise 4. Watch the next part of the video (1:57-2:44), take a look at the trends across the periods and write down all the changes that happen from left to right across a period with:

Note 1. elements

Note 2. atomic radius

Note 3. first ionization energy

Note 4. electronegativity

Exercise 5. Watch the next part of the video (2:45-3:30), take a look at the trends down a group and write down all the changes that happen with:

Note 1. elements

Note 2. atomic radius

Note 3. first ionization energy

Exercise 6. Watch the next part of the video (3:32-till the end) and complete characteristics of 3 groups of the periodic table:

Group 1: <u>the alkali metals</u>	Group (3): Halogens	Group 18:
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		(6)
metals are (1)	nonmetals become (4)	elements have a full outer shell of electrons and so are (7)
because metals react by (2)	because nonmetals react by (5)	densities and boiling points (8) on going down the group

After you watch:

Exercise 7. Predict the physical and chemical properties of elements of Group 13.



Student's Self-Study section:

Periodicity

Assignments:

1. Using example, prepare video tasks for the following video:

▪ **Group 1 as an Example of Groups in the Periodic Table**

Your video worksheet should have THREE PHASES:

- *pre-watching*,
- *while-watching* and
- *post-watching* exercises.

Learning objectives:

11.2.1.1 recognise a number of forms of the Periodic Table, historic and modern.	11.2.1.3 understand the significance of the s, p, d and f blocks.	11.2.1.5 recognise periodicity in the table and be able to account for this in terms of effective nuclear charge, ionisation energy, bond types etc.	11.2.1.7 recognise and be able to account for, in terms of effective nuclear charge, the following trends down groups: bond types, melting and boiling points, reactivity etc. (recognise and be able to account for trends down groups using (as a minimum) groups 1 and 17 as exemplification).
11.2.1.2 be able to use the Aufbau Principle to explain the shape of the modern Periodic Table.	11.2.1.4 be able to use the table to read and write the electronic configuration of any element.	11.2.1.6 recall and be able to explain general trends in melting and boiling points, atomic radius, first ionisation energy, acid/base properties (recall and explain general trends using the elements Na to Ar as exemplification).	

2. Develop one of the fragments of Lesson plan: you should use

- learning objectives above;
- a lesson plan template ([Appendix 1](#));
- one of the CLIL techniques ([Appendix 2](#));
- teaching methods.



Teaching methods:

HOW do you lead students in the topic?

- **ODD ONE OUT.** Students are given a set of words with one word that does not fit. They need to find out why and guess the topic from the remaining words. **For example,** Beryllium – Argentum – Magnesium – Calcium – Strontium – Barium. Argentum is odd word, because the rest are the Alkaline Earth Elements. Thereby, students guess the topic.
- **What sounds can you hear?** Students sit in silence for a minute while listening to recording. They need to record into the copybook all the sounds they hear. Thereby, students can guess the topic of the lesson. **For example,** a sound of combustion or explosion can mean a reaction.
- **Name Ten:** students think and write ten items that fit particular criteria. **For example,** the topic is **periodicity:** metal, non-metal, atomic radius, first ionization energy, electronegativity ...
- **Word associations:** students are given an initial word, **for example,** a table. Each student takes it in turns to say a word which they associate with the previous word. If the connection isn't obvious, challenge the student to justify their choice: a table – rows – horizontal lines - Periodic table - periodic elements ...
- **Mystery picture:** a teacher finds a picture that represents a topic of the lesson. To make the guess more difficult, a picture can be cropped into small pieces and shown separately one after another until students guess the topic.
- **Main idea and details:** students are given three details about the topic, and they need to guess the main idea from the detail clues.
- **Rebus.** The word that students will solve is a lesson topic.
- **Four pictures - one word.** Students are shown 4 images one by one, which are related to the topic, but not directly. Challenge students starting from the most difficult image, uncovering the most obvious one in the end.
- **Video.** Showing any topic-related video can be used to elicit topic from the students.
- **Unjumble / unscramble the word.** The word that students will solve is a lesson topic.
- **Showing an experiment** can also be used to introduce a lesson topic.



Model answers

2. Model answer

Properties	Na	Mg	Al	Si	P (white)	S	Cl	Ar
Atomic size	decreases	decreases	decreases	decreases	decreases	decreases	decreases	decreases
First ionization energy	increases	increases	decreases	decreases	increases	decreases	increases	increases
Electronegativity	increases	increases	increases	increases	increases	increases	increases	increases
Melting and boiling point	increases	increases	increases	increases	decreases	increases	decreases	decreases
Electrical conductivity	increases	increases	increases	zero	zero	zero	zero	zero
Bonding	metallic	metallic	metallic	covalent	covalent	covalent	covalent	-

3. Model Answers:

No	Statements	True / False
1	Periods in the Periodic Table are rows of elements whose outermost electrons are in the same principal quantum shell.	True
2	The atoms of neighbouring members differ by one neutron and one electron	False
3	First ionisation energies tend to decrease across a period.	False
4	Atomic radii decrease across a period due to decreasing nuclear charge	False
5	Positive ions are much smaller than their atoms.	True
6	Across a period, the structures of the elements change from individual atoms, through giant molecular to simple molecular.	False
7	Across a period, the chlorides of Period 3 elements change from ionic compounds that dissolve in water to covalent compounds that are hydrolysed by water, releasing fumes of hydrogen chloride and leaving an acidic solution	True
8	A column of elements thus arranged is called a row.	False
9	There is a gradual decrease in metallic character in crossing a period	True
10	Electronegativity increases across the period	True
11	Melting and boiling point decreases from Al to Si	False
12	Melting and boiling point increases from P to S	True
13	Electrical conductivity is zero from Si to Ar	True
14	Electrical conductivity decreases from Na to Al	False

4. Model Answers:

Across (→):

1. Electrical conductivity 2. Across 3. Increase 6. Proton 9. Decrease 11. metallic

Down (↓): 4. Amphoteric 5. Smaller 6. Periodicity 7. Group 8. Atomic 10. period 12. larger

5. Structured exam question

a) i) Mg and A, or *any two of* D, Br and E. (1)

ii)

	I	II		III	IV	V	VI	VII	0
1									
2									
3							W		
4									
5									

iii) Electronic configuration: 2.8.4

Name: Silicon (2)

b) i) Element A

The atomic radius of A is greater than that of magnesium because it has one more electron shell.

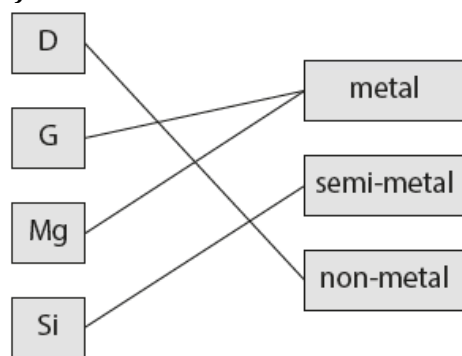
As a result, the attraction of the positive nucleus on the valence electrons is weaker in A and it ionizes more easily than magnesium. (3)

ii) $\text{Mg(s)} + 2\text{H}_2\text{O(l)} \rightarrow \text{Mg(OH)}_2\text{(aq)} + \text{H}_2\text{(g)}$ (2)

iii) A reacts with oxygen and dilute hydrochloric acid. (2)

c) i) They both have three occupied electron shells. (1)

ii)



iii) Any three of the following:

Magnesium is a solid at room temperature, whereas D is a gas.

Magnesium has high melting and boiling points, whereas D has low melting and boiling points.

Magnesium conducts electricity and heat, whereas D does not conduct electricity or heat.

Magnesium has a high density, whereas D has a low density. (3)

iv) Element G

The atomic radius of G is greater than that of magnesium because it has one fewer protons, therefore the attraction between the positive nucleus and the valence electron is weaker in G. As

a result G ionises more easily than magnesium. (3)

v) $\text{Mg(s)} + 2\text{HCl(aq)} \rightarrow \text{MgCl}_2\text{(aq)} + \text{H}_2\text{(g)}$ (2)



Video transcript: How does Periodic Table Work

Trends in the periodic table. The periodic table consists of seven rows called periods going across and 18 columns called groups going down. The elements in the periodic table are arranged according to their atomic number which is the number of protons in their nucleus. So, what do the period and the group show? Well, the period shows the element's electron shell that is being filled, for example, sodium Na in period three group one has the electronic configuration two eight one, whereas chlorine Cl also in period three but in group 17 has the electronic configuration two eight seven. In both cases it is the third shell that is being filled.

Can you see a connection between the group and element is in and the number of electrons in its outer shell? Note that if the group has two numbers, we take the second number. Pause the video while you think. The group and element is in gives the number of electrons in the outer shell of an atom of that element. Now pause the video again and write the electronic configuration for carbon atomic number 6 period 2 and group 14. The electronic configuration for carbon is two four. Did you get it right? Chemical reactions are to do with the movement of electrons. So, as all elements in a particular group have the same number of outer shell electrons they have similar chemical properties.

Let's take a look at the trends across the periods. Periodicity is the trend in properties across each period. Let's go from left to right across a period. What do you notice? First of all, elements change from metals to nonmetals. Also note that there is a decrease in atomic radius this is because more protons are in the nucleus which pull the electrons closer in. There is also an increase in first ionization energy which is the energy needed to remove the outermost electron and an increase in electronegativity which means the attraction of a bonded atom for the pair of electrons in a covalent bond.

Now let's look at the trends as we go down a group. Notice that the elements become more metallic. This is clearly seen in group 14 where carbon in period 2 is a nonmetal but lead in period 6 is a metal. By the way do you remember that metals are elements that react by losing electrons and nonmetals are elements reacting by gaining electrons. Also going down the

group there is an increase in atomic radius. This means that an extra shell of electrons is added for each successive element. However, there is a decrease in first ionization energy which as noted before is the energy needed to remove the item of electron.

There are three groups of the periodic table that are usually studied. Group 1 - the alkali metals, group 17 called the halogens and group 18 called the noble gases. As we go down Group 1 the metals become more reactive. This is because metals react by losing electrons and it is easier to lose the outer shell electron the further it is from the positive nucleus. As we go down group 17 the nonmetals become less reactive because nonmetals react by gaining electrons and the fewer shells the greater attraction for the incoming electron, and in group 18 elements have a full outer shell of electrons and so are very unreactive. Their densities and boiling points increase on going down the group.



Keys to the video:

Exercise 1. The periodic table consists of 7 rows called periods going across and 18 columns called groups going down.

Exercise 3. Question 1. according to their atomic number; Question 2. the element's electron shell; Question 3. the number of electrons in outer shell; Question 4. 2:4.

Exercise 4. Note 1. elements change from metal to non-metal; Note 2. decrease in atomic radius; Note 3. increase in first ionization energy; Note 4. increase in electronegativity.

Exercise 5. Note 1. elements become more metallic; Note 2. increase in atomic radius; Note 3. decrease in first ionization energy.

Exercise 6.

Group 1: <u>the alkali metals</u>	Group <u>17</u> (3): Halogens	Group 18: <u>Noble gases</u> (6)
metals are <u>more reactive</u> (1)	nonmetals become <u>less reactive</u> (4)	elements have a full outer shell of electrons and so are <u>very unreactive</u> (7)
because metals react by <u>losing electrons</u> (2)	because nonmetals react by <u>gaining electrons</u> (5)	densities and boiling points <u>increase</u> (8) on going down the group